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# Workplace bullying and workplace violence as risk factors for cardiovascular disease: a multi-cohort study

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## Aims

To assess the associations between bullying and violence at work and cardiovascular disease (CVD).

## Methods and results

Participants were 79 201 working men and women, aged 18–65 years and free of CVD and were sourced from three cohort studies from Sweden and Denmark. Exposure to workplace bullying and violence was measured at baseline using self-reports. Participants were linked to nationwide health and death registers to ascertain incident CVD, including coronary heart disease and cerebrovascular disease. Study-specific results were estimated by marginal structural Cox regression and were combined using fixed-effect meta-analysis. Nine percent reported being bullied at work and 13% recorded exposure to workplace violence during the past year. We recorded 3229 incident CVD cases with a mean follow-up of 12.4 years (765 in the first 4 years). After adjustment for age, sex, country of birth, marital status, and educational level, being bullied at work vs. not was associated with a hazard ratio (HR) of 1.59 [95% confidence interval (CI) 1.28–1.98] for CVD. Experiencing workplace violence vs. not was associated with a HR of 1.25 (95% CI 1.12–1.40) for CVD. The population attributable risk was 5.0% for workplace bullying and 3.1% for workplace violence. The excess risk remained similar in analyses with different follow-up lengths, cardiovascular risk stratifications, and after additional adjustments. Dose–response relations were observed for both workplace bullying and violence ( $P_{\text{trend}} < 0.001$ ). There was only negligible heterogeneity in study-specific estimates.

## Conclusion

Bullying and violence are common at workplaces and those exposed to these stressors are at higher risk of CVD.

## Keywords

Workplace • Bullying • Violence • Cardiovascular disease • Psychosocial stress • Occupational health

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## Introduction

Adverse psychosocial working conditions, including job strain, effort-reward imbalance, and long working hours are associated with a higher risk of cardiovascular disease (CVD).<sup>1</sup> Other potentially severe workplace stressors such as bullying and violence are associated with a moderately higher risk of type 2 diabetes,<sup>2</sup> but their status as risk factors for CVD remains unclear.

Workplace bullying and violence constitute different social stressors. Workplace bullying is characterized by repeated or enduring psychologically aggressive behaviours at work,<sup>3</sup> whereas workplace violence is known as the intentional use of physical force or threats of such actions at work (definitions are provided in [Supplementary material online, Text S1](#)).<sup>4</sup> As social stressors, both workplace bullying and violence may contribute to lowered self-esteem and loss of coping resources.<sup>3</sup> They may also elicit a range of coping-oriented behavioural changes, such as over-eating and excessive alcohol consumption,<sup>5–7</sup> and induce a variety of negative emotions.<sup>8–10</sup> For example, bullied individuals are three times more likely to report a depressed mood, whereas increased feelings of anger have been noted among people exposed to workplace violence.<sup>8–10</sup> In addition, both bullying and violence can lead to anxiety.<sup>9,10</sup> It has been hypothesized that these coping-oriented behaviours and negative emotions increase CVD risk,<sup>11–13</sup> along with various stress-related physiological reactions, including elevated blood pressure, increased heart rate, and systemic inflammation level.<sup>1</sup> They can also result in reduced insulin sensitivity, increased platelet aggregation, and hypercoagulability, endothelial dysfunction, and arrhythmias.<sup>1</sup>

Only a few studies have examined the risk of CVD in employees exposed to bullying at work and the results are conflicting.<sup>14–17</sup> Bullying was associated with a higher risk of incident CVD in 601 male and 4831 female Finnish hospital employees followed for 2 years with self-reported outcome, and in a case-control study of 7374 CVD cases and 7374 CVD-free controls extracted from primary care documentation from Germany.<sup>15,17</sup> However, in a cross-sectional study in the USA based on 17 524 adults, an association was noticed with self-reported angina pectoris but not with ischaemic heart disease or stroke.<sup>16</sup> These conflicting results may be due to a low number of outcome events,<sup>15,16</sup> imprecise measurements of CVD endpoints,<sup>15–17</sup> and uncontrolled or imprecisely measured key confounders, such as employment status and educational level,<sup>17</sup> making the association between workplace bullying and CVD unclear. Regarding violence, most research has focused on intimate partner violence or general violence, rather than violence occurring at the workplace specifically.<sup>18</sup> Although both environmental threats to security (e.g. national monthly homicide counts) and incidence of physical assault have shown to be associated with higher rates of CVD death,<sup>19,20</sup> the association between workplace violence and incident CVD is still inconclusive.

To address these limitations, we pooled individual-level data from three large longitudinal studies including a total of 79 201 men and women to examine the prospective associations between workplace bullying and workplace violence with incident CVD.

## Methods

### Study population

Four independent cohorts were utilized in this study, taken from the following three population-based studies: the Swedish Work Environment

Survey (SWES) (divided into two cohorts with baseline years 1995/1997/1999/2001 and 2007/2009/2011, source population: participants of Swedish Labour Force Survey; response proportion: 79%),<sup>21</sup> the Swedish Longitudinal Occupational Survey of Health (SLOSH) (baseline: year 2006/2008, source population: participants of SWES; response proportion: 65%),<sup>22</sup> and the Danish Work Environment Cohort Study (DWECS) (baseline: year 2005, source population: random sample from Danish population register; response proportion: 63%)<sup>23</sup> (Figure 1). In cohorts with multiple baseline years, we only kept the first participation record. Until 2012, SLOSH collected follow-up information on a biannual basis, and 38% of all respondents of the SLOSH2006/2008 respondents answered all follow-up surveys. Detailed descriptions of each cohort can be found in the [Supplementary material online, Text S2](#).

Using the personal identification number assigned to all residents in Sweden and Denmark, participants were linked to national registries in each country. We included employees aged 18–65 years, with no prior CVD and with information available on workplace bullying or violence, totalling a sample of 79 201 participants (Figure 1).

Ethical approval was obtained from the Regional Ethical Review Board in Stockholm for SWES and SLOSH.<sup>22</sup> DWECS was approved by the Danish Data Protection Agency (registration number: 2007-54-0059).<sup>24</sup>

### Assessment of baseline workplace bullying and violence

Workplace bullying was assessed via a self-administered questionnaire measuring whether the participant had been bullied within the 12 months preceding the baseline. Exposure to violence at work was defined as being exposed to violent actions or threats of violence at work within 12 months prior to the baseline. Please see [Supplementary material online, Table S1](#) for details. SWES and SLOSH also included information about the frequency of exposure. We constructed a dose-response variable with the categories 'frequently exposed' (exposed more than once a week), 'occasionally exposed' (less than once a week, but at least one exposure within the past 12 months), and 'not exposed'.

### Ascertainment of cardiovascular disease

Incident CVD is a composite outcome including diagnoses of the first hospitalization with coronary heart disease (CHD) or cerebrovascular disease (CD). They were identified through nationwide registries based on the International Classification of Diseases (ICD) 8, 9, and 10 codes. Main diagnoses in inpatient register (in SLOSH, SWES95-01, SWES07-11, and DWECS), outpatient register (in SLOSH, SWES07-11 and DWECS) and death registers (in SLOSH, SWES95-01, SWES07-11, and DWECS) were used. The diagnostic codes for CHD were ICD-10 I20.0, I20.1, I21–I25 (excluding unspecified angina), and ICD-8/9 410–414, whereas ICD-10 I60–I69, and ICD-8/9 430–438 were used to detect CD. Definitions of specific CVD subtypes, such as myocardial infarction (MI), ischaemic stroke (IS), and haemorrhagic stroke (HS) can be found in the [Supplementary material online, Text S3](#). Incident CVD cases were identified during the follow-up. Further information on standards and quality of CVD diagnosis in Denmark and Sweden can be found in [Supplementary material online, Text S4](#).

### Covariates

We used prior knowledge and the method of directed acyclic graph method to select covariates.<sup>25–27</sup> In addition to age and sex, we identified country of birth, educational level, and marital status as potential confounders. This information was all register-based. Educational level was classed as '≤9 years', '10–12 years', and '≥13 years'. Baseline marital status was categorized as unmarried, married/cohabiting, divorced/separated,

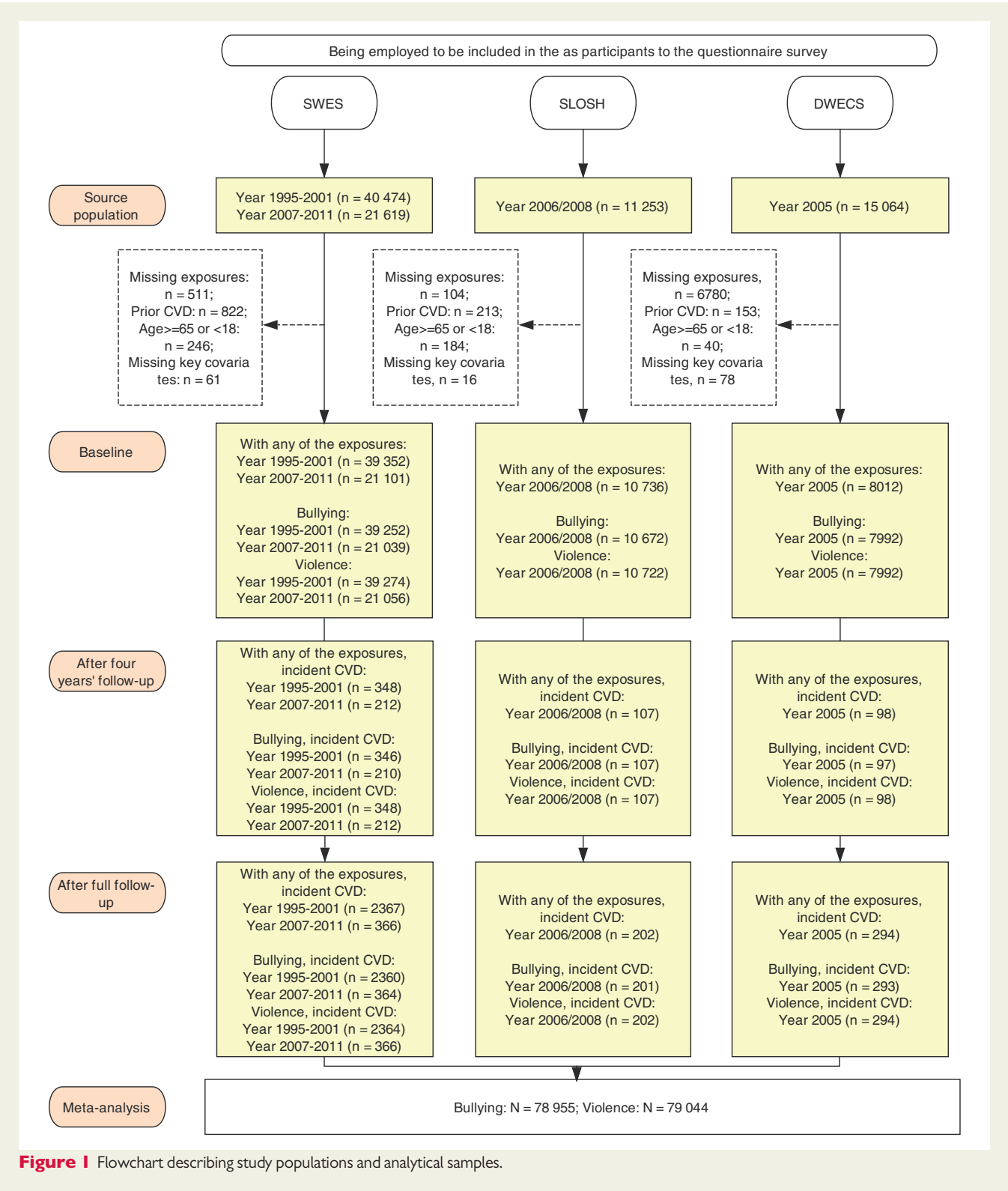


Figure 1 Flowchart describing study populations and analytical samples.

or widowed. Country of birth was categorized into 'Nordic countries', 'other European countries', and 'other continents'. Body mass index (BMI), alcohol consumption, current smoking status, and mental disorders were considered both as potential confounders and mediators, and they were thus only adjusted for in the sensitivity

analysis. We also considered the impact from other stressors at workplace, private life and other health conditions, which might be related to both the onset of exposure and the outcome. These included shift work occupations (e.g. health care professionals), occupational grade, having young children at home (<5 years of age), family-work conflict, workplace

role stressors, pre-existing diabetes, and other comorbidities [Charlson Comorbidity Index (CCI)] at or prior to the baseline examination. The measurements for these variables are described in [Supplementary material online, Texts S5 and S6](#) and [Table S2](#).

We further hypothesized that employees in occupations with frequent client contact (and thus with a higher risk of exposure to workplace violence), are better trained to cope with violence.<sup>28</sup> Hence, occupation could be a critical modifying factor. We defined social workers, personal and protective service workers, healthcare professionals, and teaching professionals as frequent-client-contact occupations. We used comparable ISCO-88 codes from DWECS, SWES95-01, SWES07-11, and SLOSH, following a suggestion in Madsen *et al.*<sup>29</sup>

## Statistical analysis

In total, eight sub-datasets (one for bullying and one for violence per cohort) with slightly varying numbers of participants were created. We applied marginal structural Cox regression to the main analyses. This approach is based on the counterfactual framework and aims to estimate the average marginal population effect, i.e. comparing a population when everyone was exposed to when everyone was not exposed.<sup>30</sup>

We calculated the individual-specific stabilized inverse probability weight.<sup>30</sup> Different logistical models were used for calculating different weights, based on propensity score models which included the specific variables considered in each adjustment. The positivity assumption was not violated in any of the analyses, meaning that both exposure statuses were possible within each confounder strata.<sup>30</sup> Before fitting the weighted Cox model, the proportional hazards (PH) assumption was tested using log-log plot and interaction between time and exposure. Here, we observed an interaction between workplace bullying and follow-up length, where the hazard ratio (HR) of bullying and CVD decreased during follow-up. Thus, we restricted our analyses to the first 4 years of follow-up on workplace bullying to meet the assumption (see other motivations for choosing the 4-year follow-up limit in [Supplementary material online, Text S7](#)). For workplace violence, full follow-up length was used as there was no violation of the PH assumption. Later, we fitted a weighted Cox PH model with age as the underlying time scale and obtained robust confidence intervals (CIs) by bootstrapping 500 times.

Other main analyses included: (i) disease subtype analyses using information for MI, HS, and IS; (ii) population attributable risk (PAR) calculation, which represents the extent to which disease burden would be eliminated, had the given risk factors removed from the population and is widely used in the planning and prioritization of certain public health interventions;<sup>31</sup> and (iii) estimation of dose-response relation. Sensitivity analysis processes are presented in [Figure 2](#).

Due to the small number of cohorts, all cohort-specific estimates were then combined using fixed-effect meta-analysis.<sup>32</sup>  $I^2$  statistic was used to test the heterogeneity of results across the cohorts. All the analyses were conducted using SAS version 9.4 (SAS Institute, Inc., Cary, NC, USA) and R package 'meta' version 4.8-4. All tests of statistical significance were two-sided and the significance level was set at 0.05.

## Results

The mean age of the participants was 43 years across the three studies and 53% were women (see [Table 1](#) and weighted summary in [Supplementary material online, Table S3](#)). There were 78 955 participants with data on workplace bullying. The prevalence of bullying varied across the studies, ranging from 8% to 13% within the past 12 months. The perpetrators of workplace bullying (in DWECS)

were mostly from inside the organization (79% were colleagues, supervisors, or subordinates) rather than from outside (21% were clients).

Data on workplace violence was available for 79 044 participants. The prevalence ranged from 7% to 17% across the cohorts within the past 12 months. We found that social workers (prevalence >46%), personal and protective service workers (>29%), healthcare professionals (>25%), and teaching professionals (>16%) had the highest exposure to workplace violence. The perpetrators of workplace violence (in DWECS) mainly originated from outside the organization (91%: clients) and less often from inside (9%: colleagues, supervisors, or subordinates).

Overall, only 10–14% of those exposed to at least one type of exposure was suffering from the other at the same time (Cohen's Kappa < 0.20). This indicates that workplace bullying and violence are two separate concepts.

## Workplace bullying and cardiovascular disease

Over a mean follow-up of 3.8 years, 760 incident CVD events were recorded, including 484 incident CHD events and 301 incident CD events, with 25 participants having both CHD and CD events as their main diagnosis during follow-up.

[Figure 3](#) shows a forest plot of the main analyses. We observed very little heterogeneity in all analyses ( $I^2 < 0.01\%$ ). After adjusting for age, sex, educational level, marital status, and country of birth, workplace bullying was associated with a 59% higher risk of incident CVD (HR 1.59, 95% CI 1.28–1.98), with the corresponding PAR being 5.0% (95% CI 2.5–8.1%). This association was presented for both incident CHD (HR 1.56, 95% CI 1.18–2.07) and incident CD (HR 1.70, 95% CI 1.19–2.44). We further observed an association with HS (HR 2.73, 95% CI 1.16–6.45) and its excess risk was much higher than for IS (HR 1.44, 95% CI 0.93–2.23). However, the estimate of HS was based on only 42 cases, generating a relatively wide CI, which overlapped with that for IS. SLOSH, SWES95-01, and SWES07-11 provided information on the frequency of workplace bullying. Of the participants who were bullied, approximately 10% were frequently bullied, whereas the remaining 90% were occasionally bullied. Dose-response relations were observed for CVD ( $P_{\text{trend}} < 0.001$ ). The highest risk of CVD (HR 2.22, 95% CI 1.23–4.01) was found among those being frequently bullied. The same trend was presented for CHD as well as CD.

The sensitivity analyses are summarized in [Figure 4](#). Excluding the first year of follow-up to reduce reverse causality gave congruous results for the main analysis. There was no evidence that sex, age, or smoking status influenced the results. Further variable adjustments or restriction of the population did not materially change the findings.

In SLOSH, there were 4066 participants (11 707 participant-observations) who responded to all follow-up waves (2006/2008–2012). With a mean follow-up of 5.9 years, 84 incident CVD cases were recorded. Among them 21% of participants were exposed to bullying at least once (10% of total participant-observations). Treating workplace bullying and other changeable characteristics (e.g. marital status) as time-dependent variables, we found a HR of 2.10 (95% CI 1.20–3.68) for the association between bullying and CVD.



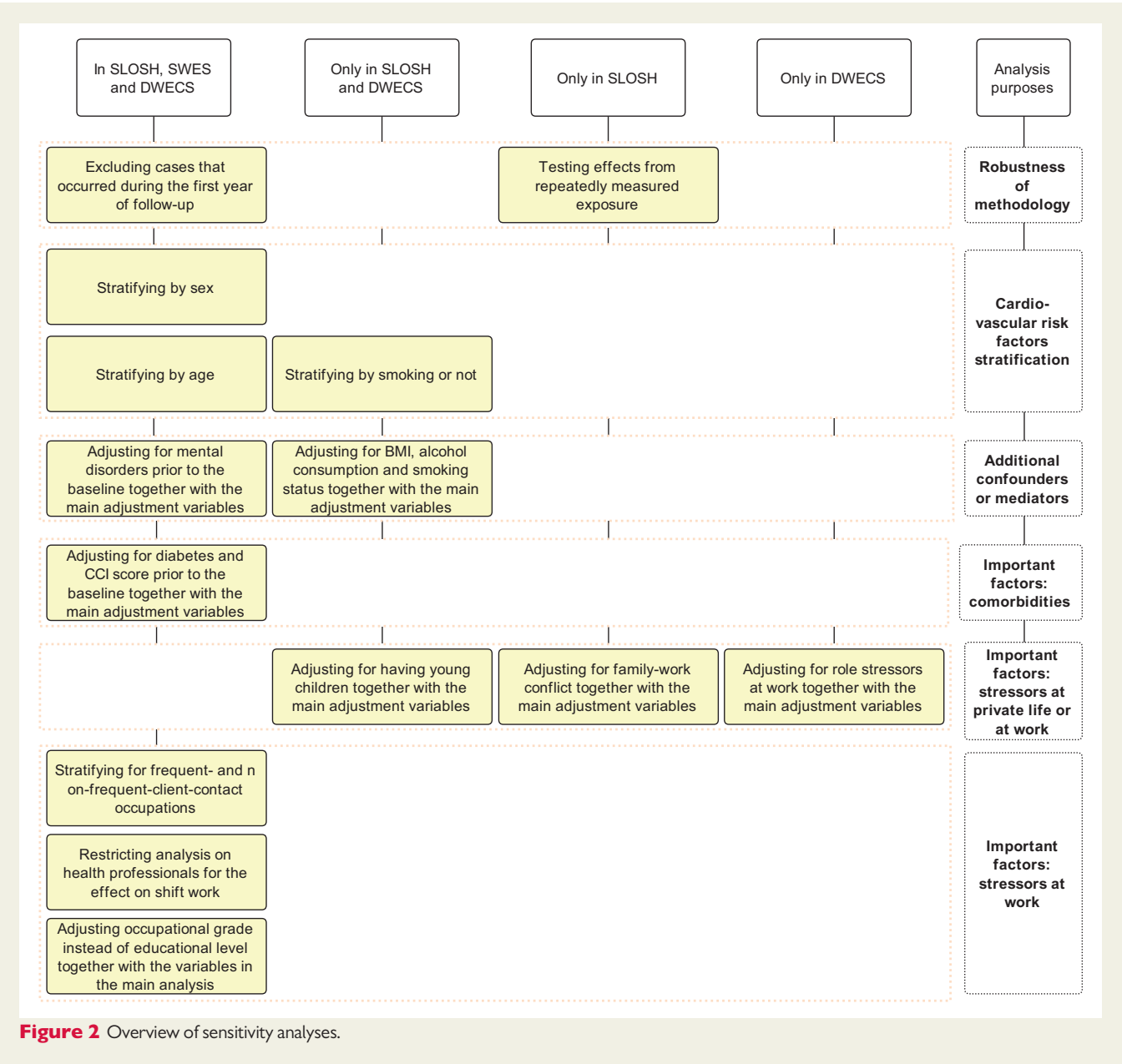
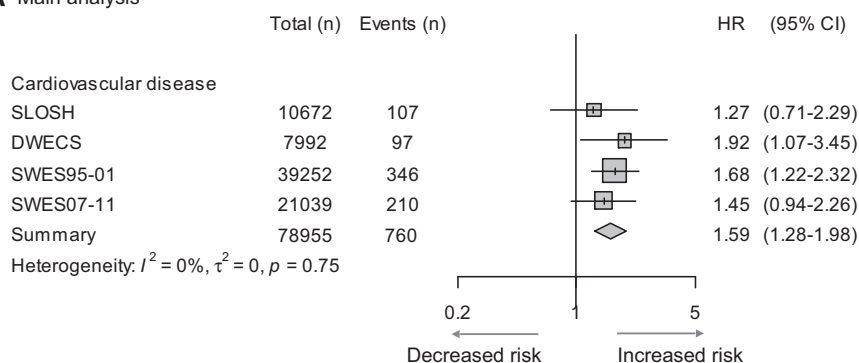
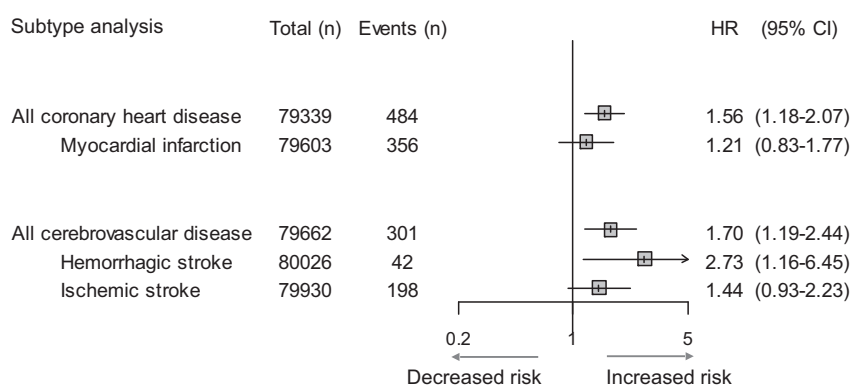
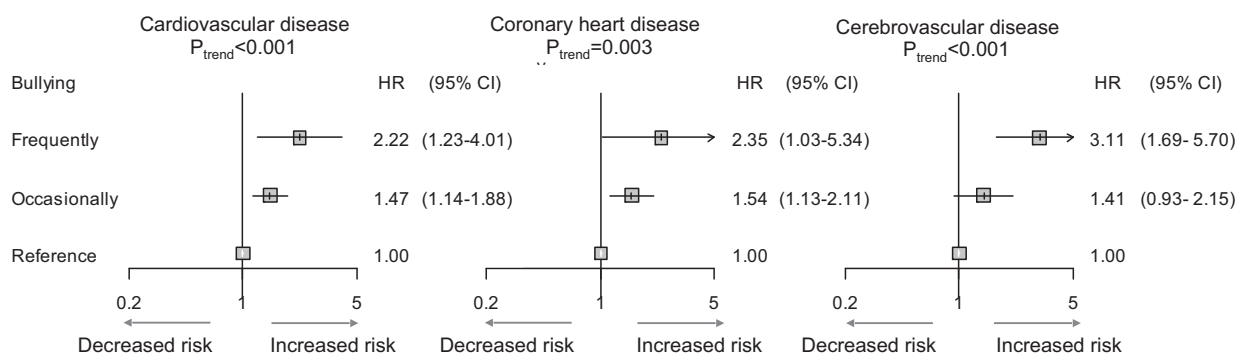


Figure 2 Overview of sensitivity analyses.

**Table 1** Summary of studies that provided individual participant data used in the analyses for cardiovascular disease, based on largest available samples with full-follow-up length ( $N = 79\,201$ ).

Study	Country	Baseline	Full follow-up lengths (mean years)	Women (%)	Age (years), mean (SD)	Bullying (%)	Violence (%)	CVD	CHD	CD
SLOSH	Sweden	2006/2008	7.0	55	47 (10.6)	13	17	26.7	16.2	10.7
DWECS	Denmark	2005	8.9	51	43 (10.4)	9	7	41.2	21.9	20.4
SWES95-01	Sweden	1995/1997/1999/2001	17.5	52	42 (11.5)	8	13	34.4	21.0	15.0
SWES07-11	Sweden	2007/2009/2011	7.1	53	44 (12.0)	8	14	24.4	14.7	10.1
Total		1995–2011	12.4	53	43.3	9	13	32.7	19.7	14.4

Incidence rate per 10 000 person-years.  
CD, cerebrovascular disease; CHD, coronary heart disease; CVD, cardiovascular disease; SD, standard deviation.

**A Main analysis****B Subtype analysis****C Dose-response analysis**

**Figure 3** Fixed-effect meta-analysis of the association between workplace bullying and cardiovascular disease, after adjustment for age, sex, educational level, marital status, and country of birth, regarding (A) main analysis of cardiovascular disease, (B) subtype analysis of coronary heart disease and cerebrovascular disease, and (C) dose-response relation analysis according to different frequencies of bullying.

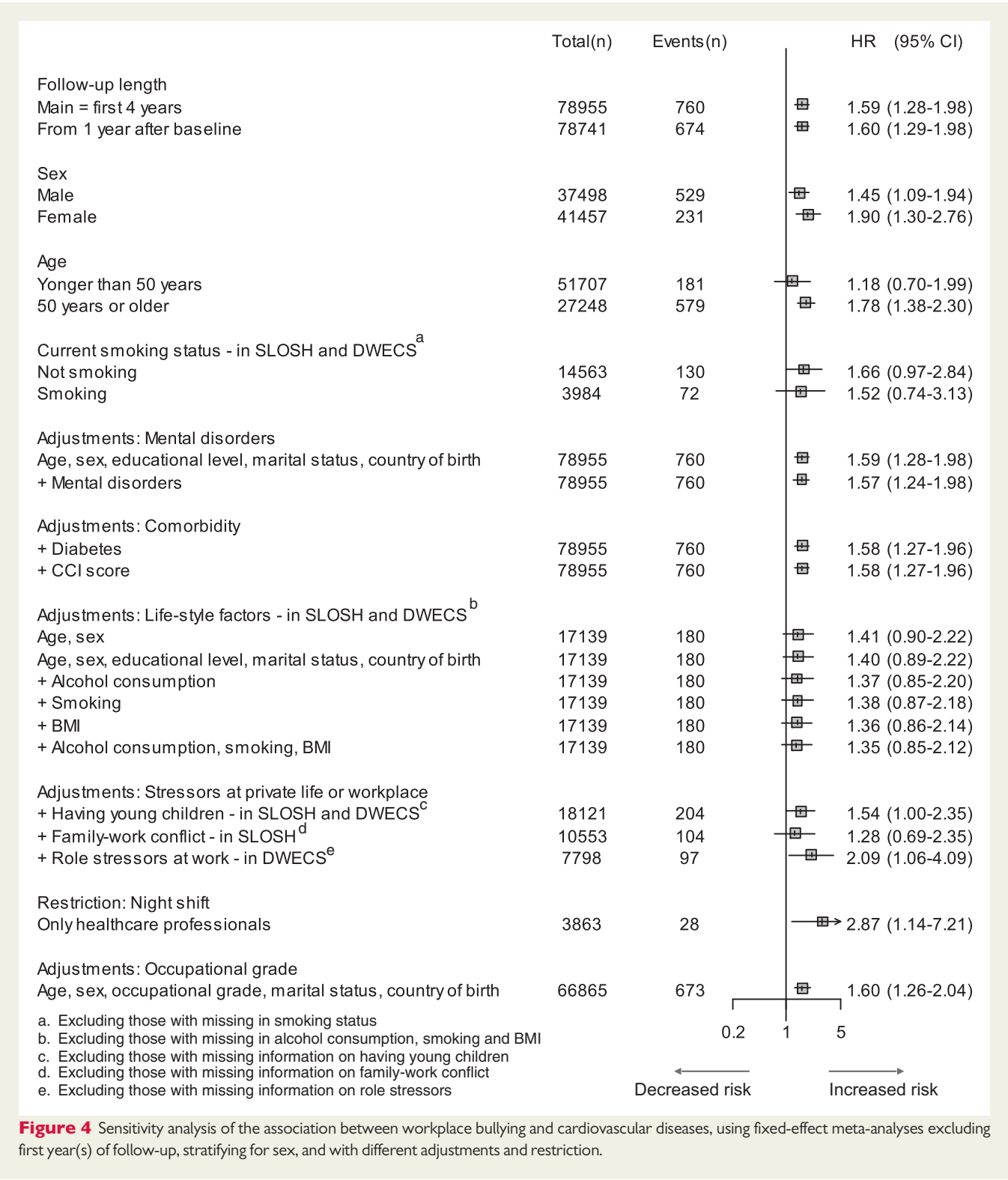
## Workplace violence and cardiovascular disease

During a mean follow-up of 12.4 years, 3226 incident CVD events were recorded, including 1971 incident CHD events and 1439 incident CD events. A total of 184 participants had both CHD and CD events as their main diagnosis during the follow-up.

Figure 5 shows that workplace violence was associated with a higher risk of incident CVD (HR 1.25, 95% CI 1.12–1.40). The corresponding PAR for workplace violence was 3.1% (95% CI 1.5–4.9%). Looking at subtypes of CVD, the association was similar for incident CHD (HR 1.21, 95% CI 1.03–1.42) and incident CD (HR 1.25, 95% CI 1.06–1.49). HS (HR 1.31, 95% CI 0.89–1.92) and IS (HR 1.33, 95%

CI 1.08–1.64) also showed similar risk estimates. There was only negligible heterogeneity across cohorts ( $I^2 = 2\%$ ). We found a dose-response relation between workplace violence and risk of CVD ( $P_{\text{trend}} < 0.001$ ). However, while the dose-response relation was presented for CD ( $P_{\text{trend}} < 0.001$ ), it was absent for CHD ( $P_{\text{trend}} = 0.22$ ). Frequent exposure to workplace violence was associated with 36% higher risk of incident CD (HR 1.36, 95% CI 0.99–1.86).

The sensitivity analyses are summarized in Figure 6. By limiting the follow-up length to the first 4 years, and excluding the first year of follow-up, the sensitivity analyses showed similar associations. No sex, age, and smoking status differences were observed, and further



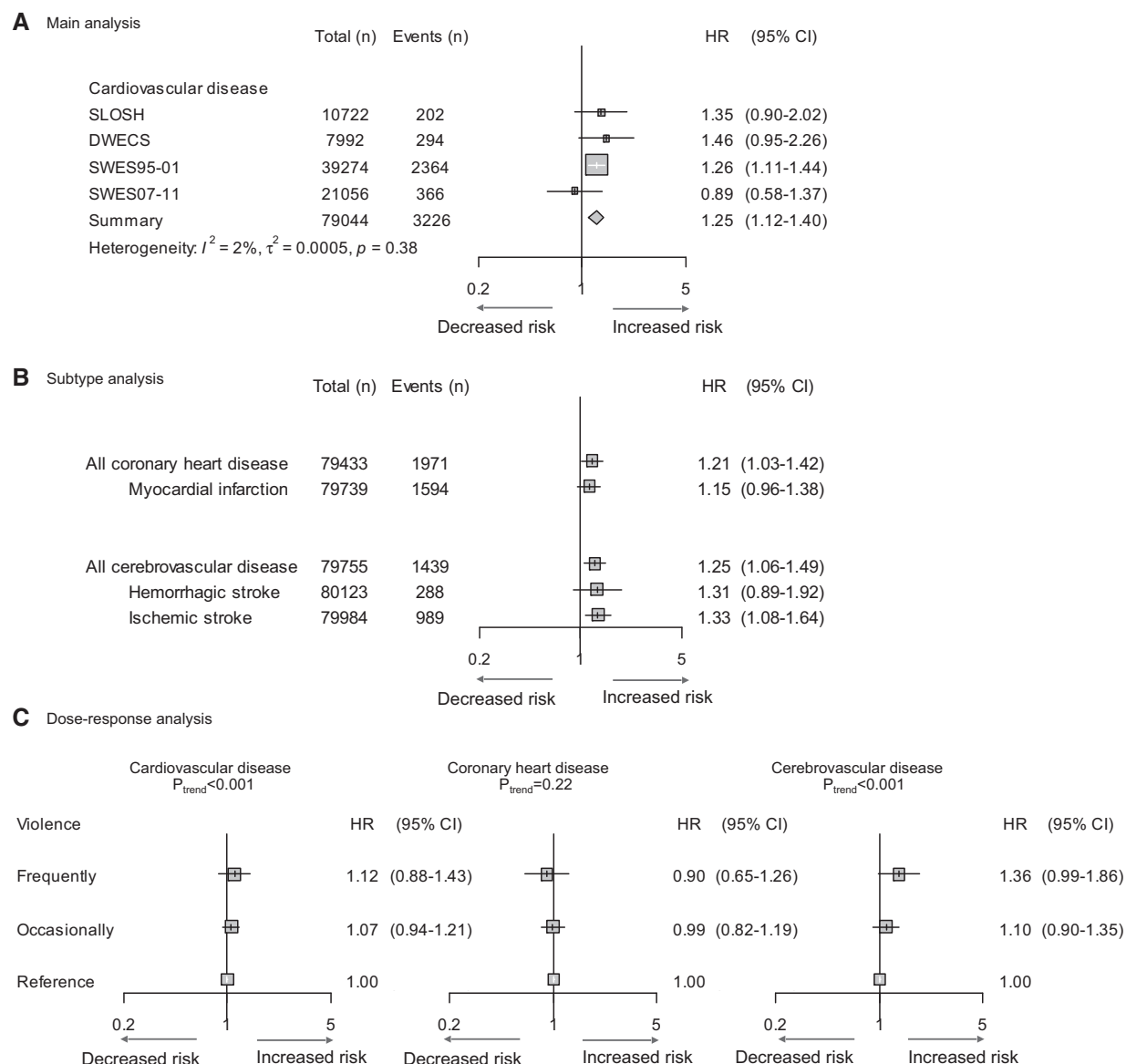
**Figure 4** Sensitivity analysis of the association between workplace bullying and cardiovascular diseases, using fixed-effect meta-analyses excluding first year(s) of follow-up, stratifying for sex, and with different adjustments and restriction.

adjustments did not change the effects. Moreover, we observed a stronger association between violence and CVD among people employed in non-frequent-client-contact occupations (HR 1.32, 95% CI 1.13–1.56) than among those whose occupations involved frequent client contact (HR 1.15, 95% CI 0.99–1.34), but with overlapping CIs. The latter type of occupation also shared similar results

with the restricted analysis on health care professionals (night shift workers) (HR 1.06, 95% CI 0.68–1.63).

Among the 4751 participants of SLOSH (11 747 participant-observations) who responded to all survey waves (2006/2008–2012), the mean follow-up was 5.9 years and 86 incident CVD were recorded. Of the participants, 17% were exposed to violence at least once





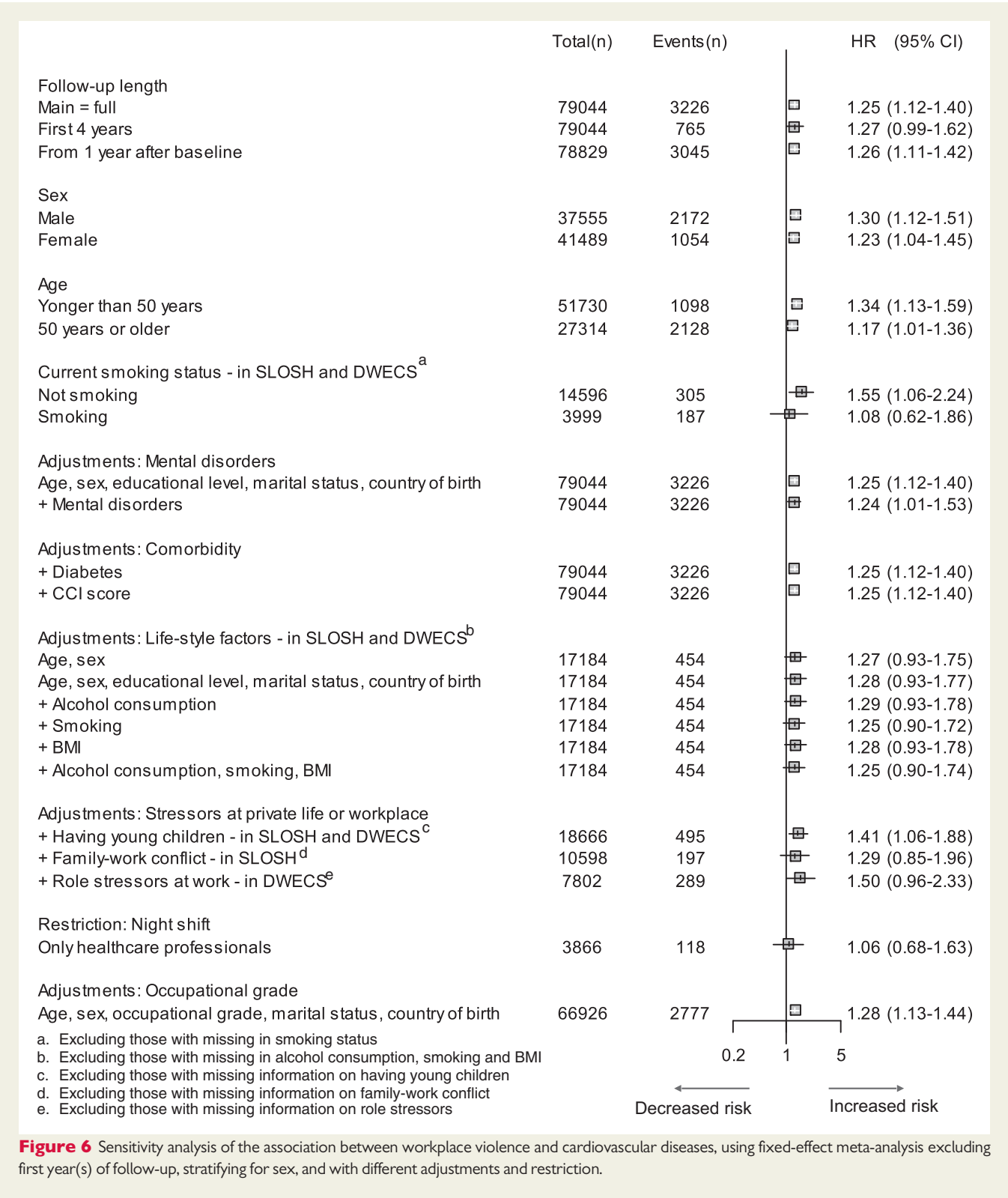
**Figure 5** Fixed-effect meta-analysis on the association between workplace violence and cardiovascular disease, after adjustment for age, sex, educational level, marital status, and country of birth, regarding (A) main analysis of cardiovascular disease, (B) subtype analysis of coronary heart disease and cerebrovascular disease, and (C) dose-response relation analysis according to different frequencies of violence.

(12% of total participant-observations). Treating workplace violence and other changeable statuses, e.g. marital status as time-dependent variables, we found 1.22 times (95% CI 0.61–2.44) higher risk of having CVD among those exposed to violence, which is consistent with our main analysis from the SLOSH data (HR 1.35, 95% CI 0.90–2.02).

## Discussion

In this large multi-cohort analysis involving nearly 80 000 employed men and women from Denmark and Sweden, we found consistent support for our hypothesis that workplace bullying and workplace

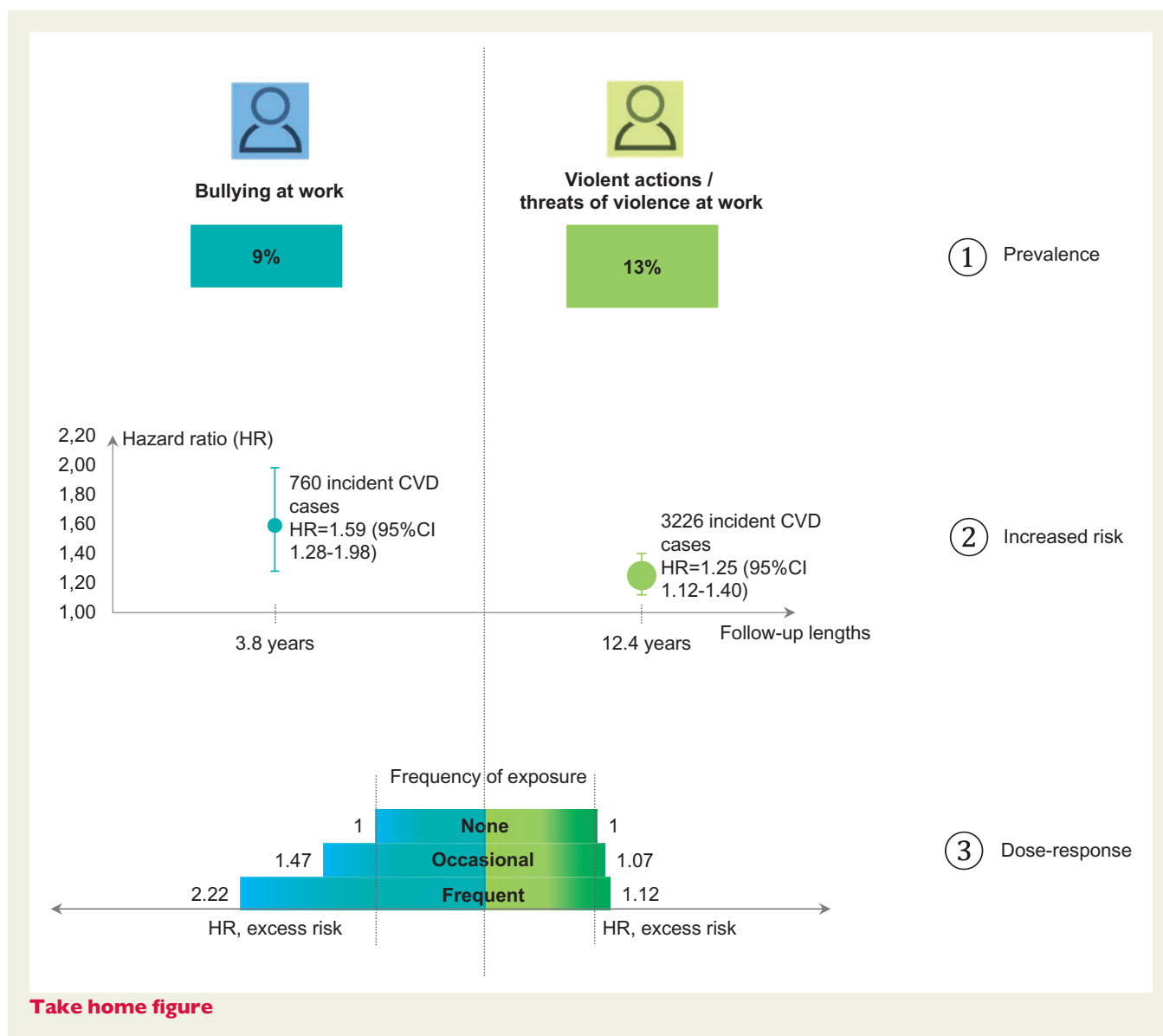
violence are associated with a higher risk of new-onset CVD. The PAR was 5.0% for workplace bullying and 3.1% for workplace violence, comparable to those for standard risk factors, e.g. diabetes (4%) and risky drinking (3–6%).<sup>33,34</sup> In this case, if the association was causal, removing workplace bullying and workplace violence from the baseline population prevented 5.0% and 3.1% of the CVD cases, respectively. The dose-response relation was evident for both workplace bullying and violence, with the highest risk observed among those exposed on a weekly/daily basis. We observed no heterogeneity between study-specific estimates, and there were no sex differences in the results. The results were robust for different follow-up periods, adjustments, and cardiovascular risk stratifications.



Workplace bullying

Our findings of a higher risk of CVD among those exposed to bullying corroborate with previous studies on the topic. A smaller longitudinal study conducted by Kivimäki et al.<sup>15</sup> based on a broader self-reported assessment of CVD (hypertension, CHD, and CD) showed

that workplace bullying was associated with a 2.3 times higher risk of CVD (95% CI 1.2–4.6). After BMI adjustment the risk estimate was similar to the one observed in this study, but no longer statistically significant [odds ratio (OR) 1.6, 95% CI 0.8–3.5]. Jacob and Kostev,<sup>17</sup> using similar CVD definitions as our study, also found similar



associations (OR 1.31, 95% CI 1.01–1.77), and their findings were not affected by further adjustments for overweight.

## Workplace violence

We are not aware of previous studies concerning workplace violence and incident CVD. Our results are in agreement with findings from a recent case-control study from Russia based on 1750 cases and 2000 controls, concerning general violence. They found that physical assault was associated with a 2.14 times higher risk (95% CI 1.05–4.34) of ischaemic heart disease death and a 4.36 times higher risk (95% CI 1.90–10.00) of CD death.<sup>20</sup> As our study, to the best of our knowledge, is the first longitudinal investigation of the relation between workplace violence and incident CVD, our findings need to be replicated in other studies. Evidence of a dose-response relation for workplace violence was not as strong as for bullying and only appeared for CD, and not for CHD. It is possible that those most

frequently exposed to violence are also those working in frequent-client-contact occupations, as shown in our study. They may be more capable of tackling violence at work with cognitive adaption and their organizations may be also better geared towards preventing long-term consequences of workplace violence.<sup>8,28</sup> This might be demonstrated by the similar CVD risks observed between frequent- and non-frequent-client-contact occupations in our study. Another explanation is that the intensity rather than the frequency of violence is critical in triggering of CHD events. Therefore, more research is needed to clarify the dose-response relation.

## Plausible mechanisms

Workplace bullying and violence are major social stressors. They are likely to induce negative emotions and stress reactions as pathways to CVD development. They may lead to conditions such as anxiety and depression.<sup>8,10,15,28</sup> These negative emotions may also stimulate

behaviours related to passive coping, such as over-eating and excessive alcohol consumption.<sup>5–7</sup> Further, activation of the physiological stress response system and activation of the hypothalamic–pituitary–adrenal axis may be involved in direct and indirect mechanisms, e.g. directly causing a higher level of saliva dehydroepiandrosterone and a lower level of saliva cortisol.<sup>2</sup> These hormones may have a direct impact on heart rate and blood pressure, subsequently leading to hypoperfusion and increased cerebral blood flow pulsatility.<sup>1</sup> Physiological stress response may be closely related to emotional distress and behavioural changes,<sup>11,12</sup> indirectly contributing to the elevated level of blood pressure and a greater progression in intima-media thickness.<sup>13,35</sup> We did not observe attenuation for both workplace bullying and violence after adjusting for health-related life style factors, but they may still act as mediators. Therefore, further research is needed to investigate these emotional, behavioural, and physiological pathways.

On the other hand, workplace bullying and violence may also have distinct mechanisms. For example, the effect of workplace bullying was markedly affected by follow-up length, while this was not the case for workplace violence. It is plausible that bullying can exacerbate pre-existing CVD risk, such as high atherosclerotic plaque burden.<sup>1</sup> As those who were bullied at work were very likely to change their job,<sup>36</sup> this exacerbation might be alleviated after the change. Furthermore, the excess risk associated with bullying was noticeably higher for HS than IS. HS is more strongly associated with high blood pressure than IS.<sup>33</sup> Accordingly, elevated blood pressure may be more pronounced in the mechanistic pathway between workplace bullying and CVD.<sup>16,37</sup> However, with the overlapping CIs of HS and IS, this latter hypothesis may be a chance finding. Thus, more research is needed to confirm the underlying mechanisms.

## Limitations and strengths

In our study, workplace bullying and violence were measured only once, potentially causing some degree of misclassification of long-term exposure.<sup>3</sup> However, the supplementary analysis using repeated measures in SLOSH suggests that this is not a major source of bias. Our study was conducted in a Nordic setting, where the concepts of workplace bullying and violence are well-established,<sup>38</sup> but caution is needed when generalizing the results to other cultural settings, where individuals may perceive workplace bullying and violence differently. Additionally, information on potential confounders such as tobacco use other than smoking (e.g. snus), personality, negative emotional traits, genetic factors, other stressors at private life (e.g. marital conflict), and other work-related stressors were not available in the studies. Further data to evaluate causation and mechanisms for the associations, such as the severity of the exposures and measurements of stress hormones, blood pressure, blood cholesterol, or heart rate variability, were not available to us.

However, importantly, in contrast to previous studies, we were able to link survey data to nationwide registries to identify new cases of definite CVD with nearly complete follow-up. Our large sample size and long follow-up period allowed us to assess the total effects, subtype effects and dose–response relation. It also allowed us to perform relevant sensitivity analyses on different stratifications, adjustments, and restriction with sufficient statistical power.

## Conclusion

Bullying and violence are common workplace stressors. Our study sheds light on their association with a higher risk of cardiovascular events. If the association is causal, eliminating workplace bullying and violence would prevent a sizable number of CVD events from happening. Further research is needed to determine whether preventive measures directed towards bullying and violence may reduce CVD risk as well as to investigate the underlying mechanistic pathways.

## Supplementary material

Supplementary material is available at *European Heart Journal* online.

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